PRACTICAL WIRELESS

JUNE 1977

40p

The NEW PW TELE~

TENNIS
FOOTBALL
SQUASH
PELOTA

also: CW FILTER UNIT
VERSATILE AF GENERATOR

PW TELE~ TENNIS / FOOTBALL / SQUASH / PELOTA

plus:~ ON-SCREEN SCORING & SOUND EFFECTS

THE General Instruments AY-3-8500 television games integrated circuit allows a complex multigame unit to be built using very few additional components. The single device provides for 4 ball games and 2 shooting games. This article will describe a unit for the 4 ball games.

THE AY-3-8500

Before describing the construction of the unit it will be useful to give a description of the special IC. The device is in a standard 28 pin dual-in-line package with pins 1, 14, 15 and 28 not being used. Pins 2 and 4 are ground and plus 8V respectively.

★ components list

Resistors

R1	47kΩ
R2	1kΩ
R3	10kΩ
R4	2·2kΩ
R5	220Ω
R6	220Ω
R7	47kΩ
R8	1kΩ
R9	47kΩ
R10	47kΩ
R11	47kΩ
R12	47kΩ
R13	33kΩ
R14	47kΩ
R15	1kΩ
R16	6·8kΩ
R17	4·7kΩ
R18	1kΩ
R19	100Ω
R20	100Ω
VR1	10kΩ standard horizontal preset
VR2	10kΩ standard horizontal preset
VR3	1kΩ standard horizontal preset
VR4	100kΩ linear
VR5	100kΩ linear

All fixed resistors are ¼W, 5%

Capacitors

C1	2200μF, 25V
C2	0·22μF
C3	0·22μF
C4	1000pF polystyrene
C5	1000pF polystyrene
C6	100pF polystyrene
C7	100pF polystyrene
C8	0·22μF
C9	0·22μF
C10	10μF, 10V
C11	1000pF disc ceramic
C12	10pF plate ceramic
C13	3·3pF plate ceramic
C14	22pF plate ceramic
C15	5·6pF plate ceramic
C16	1000pF disc ceramic, 250V
C17	1000pF disc ceramic, 250V
C18	47μF, 10V tantalum

Switches

S1	1 pole 6 way rotary.
S2	Single pole, biased off, miniature push
S3	S.P.S.T. miniature toggle.
S4	S.P.S.T. miniature toggle
S5	S.P.S.T. miniature toggle
S6	S.P.S.T. miniature toggle
S7	D.P.S.T. miniature toggle, mains rated

Semiconductors

Tr1	BC108
Tr2	BC108
Tr3	BC108
Tr4	BC108
Tr5	BSX20
D1	1N4001
D2	1N4001
D3	1N914
D4	1N914
IC1	AY-3-8500 G.I.
IC2	MC7808 or 78L82AWC

Miscellaneous

T1, mains transformer, 2 secondaries each 0–12V at 250mA, fixing centres 53·5mm. FS1, fuse holder, chassis mounting, 20mm and 200mA fuse. PCB from Readers PCB Service. Speaker, miniature, 40Ω. Former 4mm with dust core. Wire 40SWG enamel covered, 1metre long. Wire 22SWG, tinned copper, 250mm long. Case sloping top, 216mm x 130mm x 47mm (front) x 79mm (back), Watford code NJSF2 Doram code 509-608. Boxes, 2 off, 85mm x 56mm x 37mm, Watford code NJHC1 Doram code 509-636. (Note, these cases provide an attractive cover but any case of similar size can be used). SKT1, coax socket. Coax cable and 2 coax plugs. 2 grommets. Mains cable. Board pins. DIL socket (see text). Heat sink for IC2

D.S.COUTTS

Fig.1. The outlines of the four games that can be played using this unit. The sizes of the individual dots may not be as shown due to tube distortion and sharpness of focus.

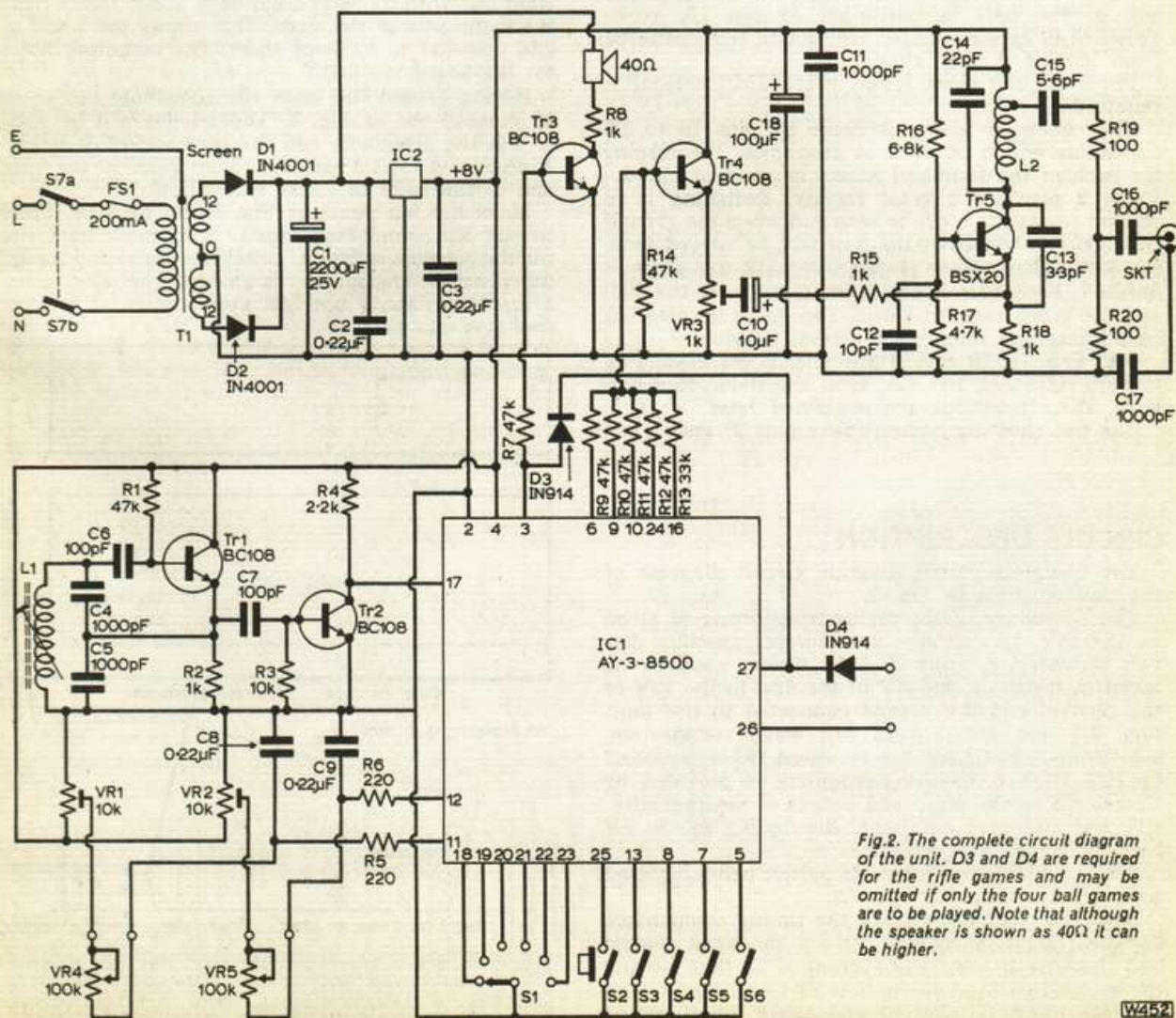



Fig.2. The complete circuit diagram of the unit. D3 and D4 are required for the rifle games and may be omitted if only the four ball games are to be played. Note that although the speaker is shown as 40Ω it can be higher.

Pin 3 gives an output of 500Hz, 1kHz or 2kHz which corresponds to the ball hitting the line, the ball hitting the bat and a scoring signal.

The ball will bounce off the correct bat at an angle determined by the condition of pin 5. When it is left open circuit the angle is constant over the whole bat except that the reflection is 'up' in the upper section of the bat and 'down' in the lower section. When pin 5 is connected to ground the bat is divided into four vertical sections. The angles in the centre two sections are as before but the outer two reflections are at steeper angles.

Pin 7 controls the ball speed. If left open circuit the ball travels slowly (suitable for beginners) if connected to ground the ball speeds up.

Automatic or manual service is selected by pin 8. If the ball leaves the court when pin 8 is open circuit it will remain off until the pin is grounded momentarily. If pin 8 is left switched to ground the ball will serve automatically, travelling in the direction that it left the ground (ie. if the right hand player scores then the ball will be served from the right hand side).

Pin 11 is the right player input and an R/C network on this pin controls the vertical position of the right bat or, in football, both right bats. Pin 12 provides similar control for the left hand player. The size of the bats is controlled by pin 13. When switched to ground the bat size is half that resulting from leaving it open circuit.

Pin 17 is the clock input and a 2MHz signal is required.

The choice of games is made by pins 18 to 23, depending which of them is grounded. The display for each of the four ball games is given in Fig. 1.

Pin 2 provides a reset facility. Switching it to ground resets the score to zero and when the ground connection is removed the ball will be served from the left. When either player scores 15 the game is finished. Both bats become transparent to the ball and the score remains static. The game is restarted by pushing and releasing the reset button.

Pins 6, 9, 10, 16 and 24 are outputs corresponding to ball, right bat, left bat, sync and field/score outputs. Their functions are explained later.

The two shooting games utilise pins 26 and 27.

CIRCUIT DESCRIPTION

The complete circuit diagram circuit diagram of the unit is given as Fig. 2.

The secondary of the mains transformer is given as 12-0-12V. In fact, the transformer specified has two secondaries, each of 12V. These need to be wired in series (ie, the OV of the first to the 12V of the second) and the ground connected to the junction. D1 and D2 provide full wave rectification, smoothing is by C1 and the resultant DC is regulated by IC2. High frequency decoupling is provided by C2 and C3 on the input and output of the regulator. C11 and C18 give additional decoupling to the 8V rail.

Tr1 is a 2MHz oscillator, its output being buffered by Tr2 before being fed to IC1.

VR1, VR4, R5 and C8 are the timing components for the right hand player. VR4 is the hand control and changes the charging current of C8 thus moving the vertical position of the bat. VR1 sets the voltage towards which C8 charges and alters the sweep of the bat. R5 limits the current during the discharge period at frame flyback. The corresponding controls for the left hand player are VR2, VR5, R6 and C9.

Tr3 drives the speaker, with R8 limiting the volume. If greater volume is required the value of R8 can be reduced but, on the prototypes, it was sufficient for most domestic uses.

The video and sync outputs are summed by R9 to R13 and drive Tr4, an emitter follower. VR3 in the emitter allows the modulation level of Tr5 to be adjusted.

Tr5 is VHF oscillator operating at about 170MHz with harmonics extending into the UHF band. The output is divided by R19 and R20 and the unit is DC isolated from the display monitor by C16 and C17.

Switches S1 to S6 control the games and functions already described, (see Fig. 7 for details also).

CONSTRUCTION

Before commencing construction of the electronics it is necessary to drill the mounting holes in the case. The board can be used as a template to ensure they are in the right position. The board will ultimately sit with the modulator section at the front right and with its right hand edge about 10mm from the right side of the case. This allows the leads of C16 and C17 to be kept short. The mounting holes for the board are 6 BA.

Having drilled the base, the remaining holes can be marked out as Fig. 3. These holes will be sized to suit the grommets and the coax socket. It is also advisable to drill a series of 5mm holes in the base and in the back to assist ventilation.

Mark the top panel as Fig. 4 and drill the holes to suit the components used. A suitable hole size for the speaker is 20mm. Label the panel and mount the switches. The speaker is glued to the panel using a rapid-cure epoxy but first glue a piece of speaker fret over the hole.

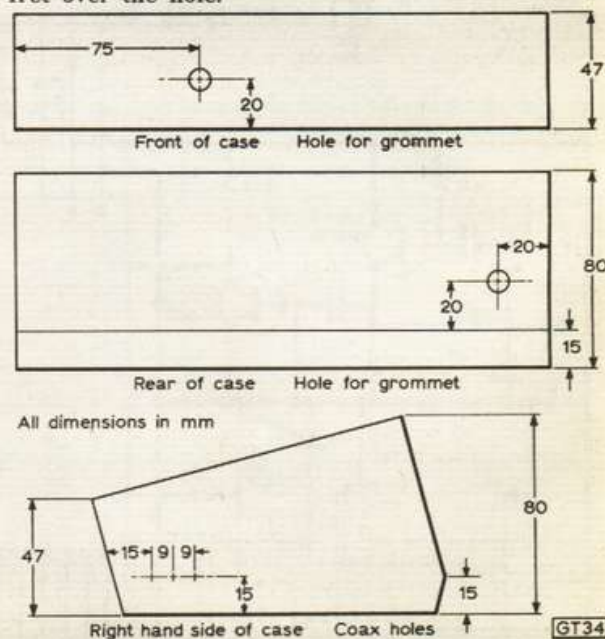



Fig.3. Suitable drilling hole locations and sizes are shown for the box specified. The single hole in the front of the case is for both the bat control leads. It is easier to identify the bats if two holes are made, one at each end of the front.

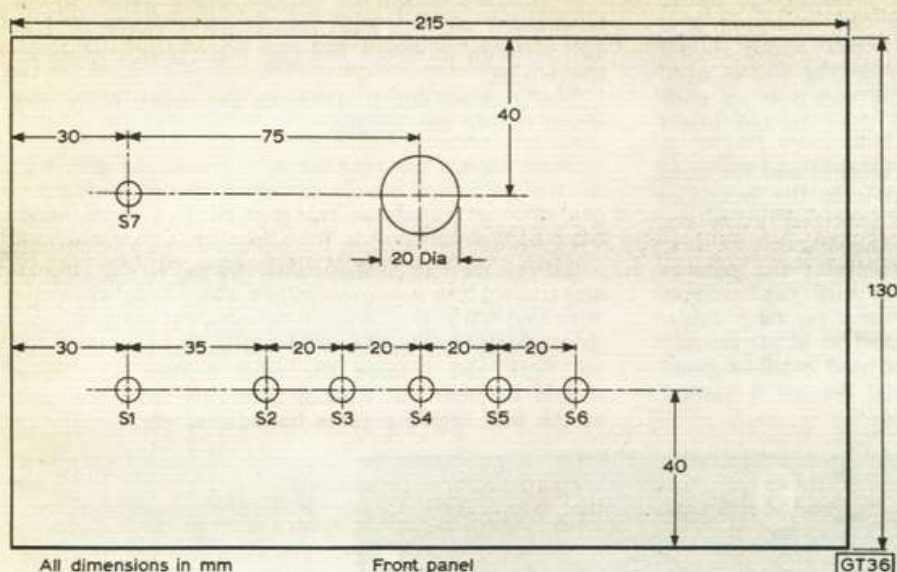



Fig.4. The drilling details for the lid of the case specified. If a different case is used, ensure that there is sufficient depth beneath the panel for the switches.

Most of the components are mounted on a single sided PCB. Fig. 5. shows the wiring pattern and Fig. 6 the component locations. The former for L1 is stuck in position, again using rapid-cure epoxy, and when the adhesive has set, 50 turns of 40 SWG are wound onto the former. After soldering the ends as shown in Fig. 6, the screening can is fitted. It is better to wind the coil after the former is fixed to the board because although it is difficult to wind it is even more difficult to hold the winding in place whilst the epoxy sets.

The remaining components, except for the coil L2 and IC1 are mounted (not forgetting the wire link). L2 is 3 complete turns of 22 SWG tinned copper wire wound on a former so that the diameter of the coil is 6mm (¼ inch) after the former is removed. A short length of wire is soldered to the coil ¾ of a turn from one end. The coil is mounted in position and the screen is soldered to the four pins at the corners of the oscillator section. Leave the top of the screen off. It may be necessary to adjust the frequency. Details of the screen are given as Fig. 7.

It is strongly recommended that a socket or Soldercon pins are used for IC1. This device is of MOS construction and is liable to damage if incorrectly

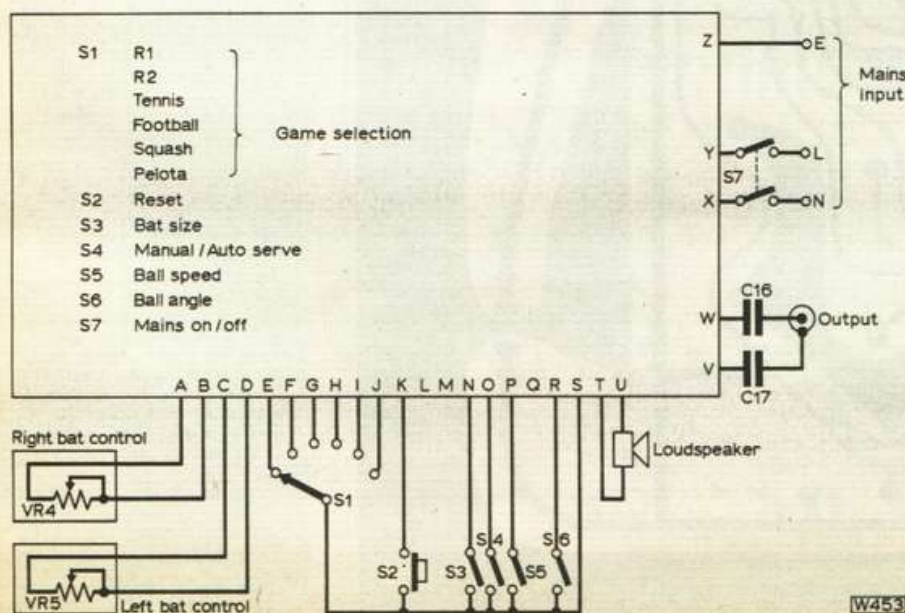
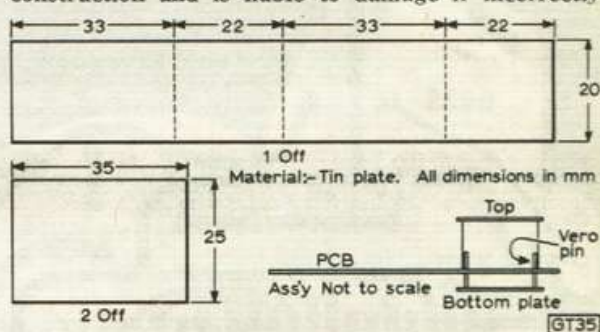



Fig.7. Cutting and folding details for the screen required round the modulator section. Since the position of the pins is fixed the folding needs to be fairly accurate to allow for soldering.

Fig.8. The connections from the PCB to the control are shown separately in this diagram to permit easy assembly. The same connections are shown, but not identified, on the circuit diagram (Fig.2.)

handled. If for any reason it is necessary to solder the IC directly into the board the soldering iron must have an earthed tip and a heat shunt should be used on the pin being soldered. The socket need only be a 24 lead type since the end pins on each side are unused. If a socket is used do not insert IC1 yet.

Recheck the board for solder bridges and for good soldered joints and then mount it in the box. The dimensions given for the box specified allow for 6mm (¼ inch) spacers beneath the board.

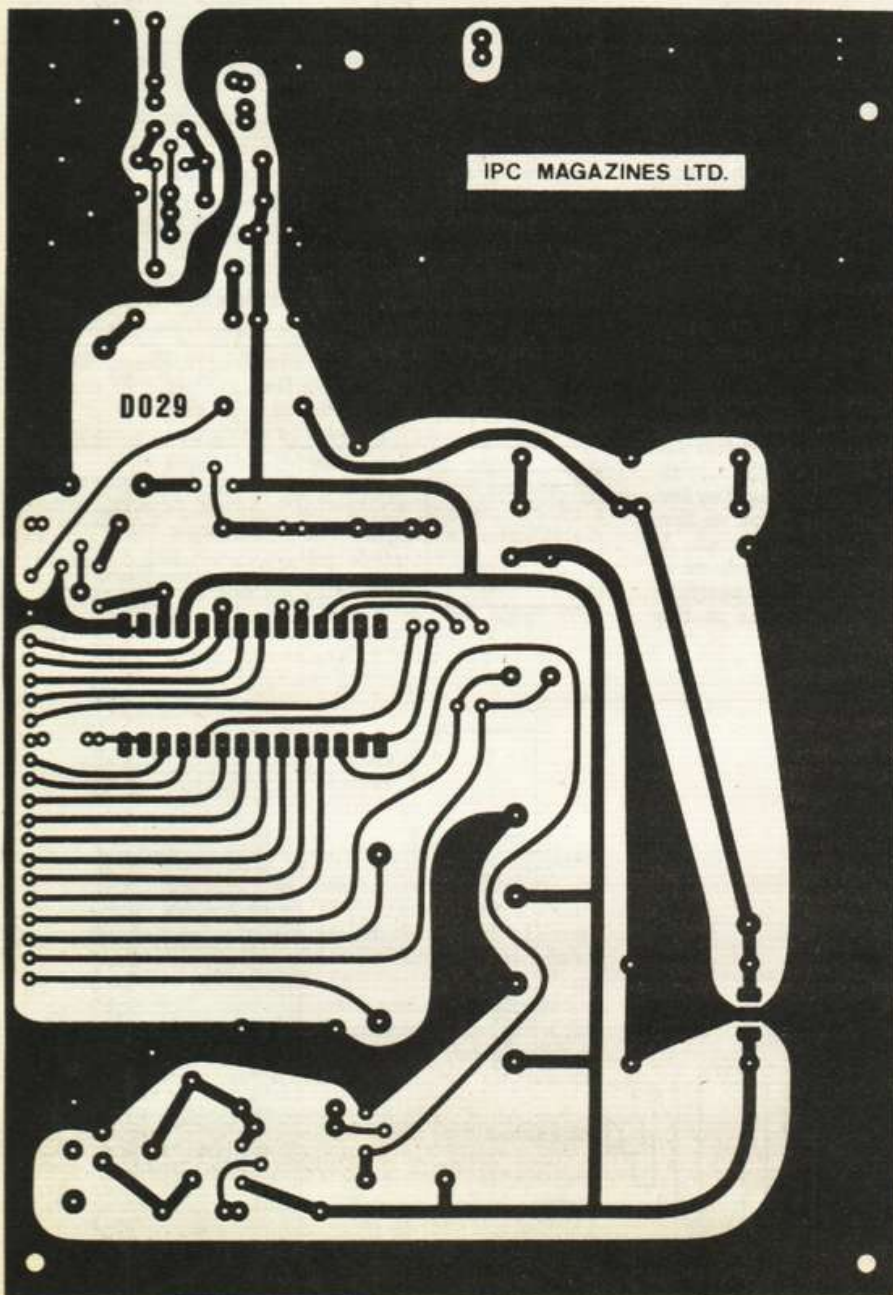
Connect the off-board components to the pins as shown in Fig. 8. The leads for the bat controls should be about 1 metre long and be twin cable. The variable resistors are mounted in small boxes.

Some pins on the board are not used in this 4 game unit although S1 is shown wired for all 6 games. Pins E and F can be left unwired.

A suitable length of coaxial cable needs to be terminated at both ends and a mains cable, preferably terminated with a 13A ring main plug, completes the wiring.

Now remove the IC from its protective foam and insert it into the holder.

SETTING UP

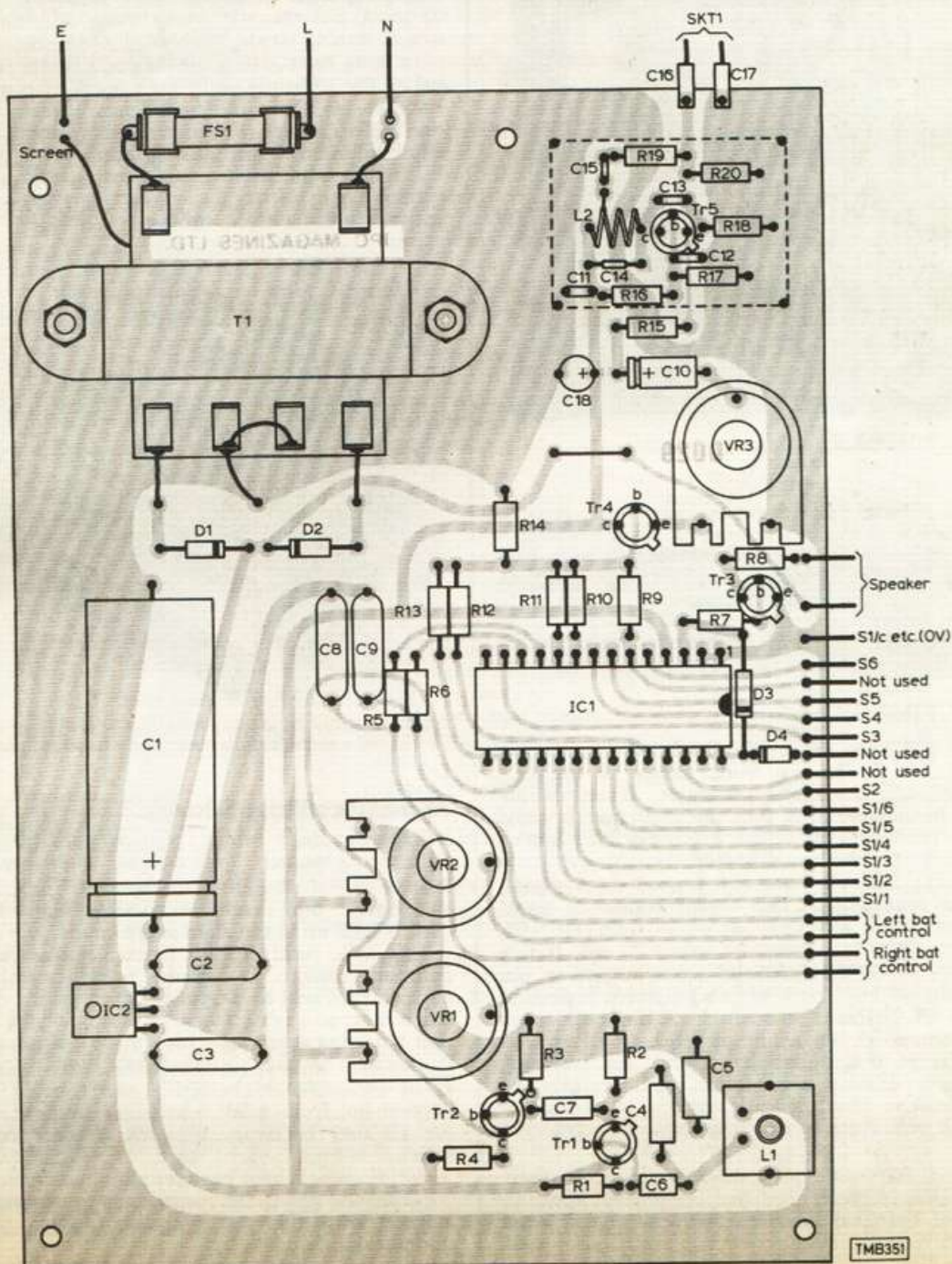
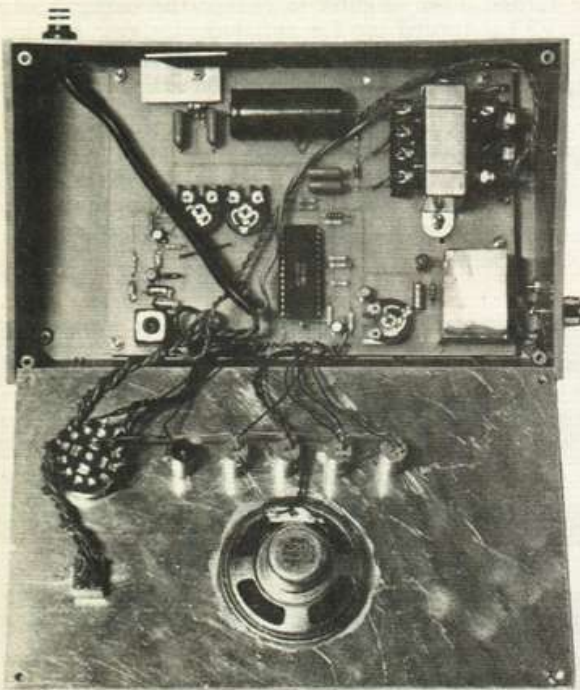
Set the core of L1 flush with the top of the former and space L2 to approximately 7·5mm long. Set VR1, VR2 and VR3 to mid position, select football on the games unit and select auto serve. Switch the unit on, push and release the reset button S2. Tones should be heard at regular intervals from the unit as the ball hits the game boundaries etc.

◄ *Fig.5. The wiring pattern of the printed circuit board, shown full size. For those intending to make their own boards we would stress the need for great care in laying out the IC pads and the modulator section. The earth section could be increased to conserve the etchant.*

► *Fig.6. The component layout and orientation for the PCB. Although the outputs are not identified they conform to those shown in Fig.8. Note the tight layout of the modulator section and hence the need for careful cutting and folding of the screen.*

If all is well, switch the monitor on, allow it to warm up, select a spare U.H.F. channel and plug the games unit into the aerial socket. Carefully tune the viewer until the signal from the games unit appears on the screen, it may only consist of white streaks covering the screen. Slowly screw the dust core into L1 until the streaks on the screen resolve themselves into the outline of the football pitch as shown in Fig. 1. It may be necessary to re-adjust the viewer, tuning again for a good signal. Several signals will be picked up throughout the U.H.F. band, choose the best one.

When the reset button is pushed and released the football field should appear locked solid on the screen, if it does not adjust L1 slightly one way or the other until it locks into sync each time it is reset. When the field is stable on the screen, VR3 may be adjusted anticlockwise to increase the contrast and the brightness control on the viewer may be turned down slightly to reduce the background. (If VR3 is turned too far anticlockwise sync will be lost.)

If the signal from the unit is close to a TV station L2 may be altered in length to move the games frequency up or down the band a little, then the screening cover can be fitted.

Check that the bats sweep across the screen. VR1 and VR2 may be turned anticlockwise to reduce the

sweep of the bats but if they are turned too far the bats will disappear since the ramp will not reach the I.C. trigger level. Check the other games and the various switch functions and if it all checks out, screw the lid on the case.

A general photograph of the unit with the lid removed. The retainer for the mains cable has been removed to allow the lid to be inverted. It should be positioned to avoid too much cable inside the box when re-assembled. The short leads of the capacitors coupling the board to the output socket can be identified. These two capacitors prevent any possibility of mains being fed to the unit from the television chassis if the set has its mains reversed.

FAULT FINDING

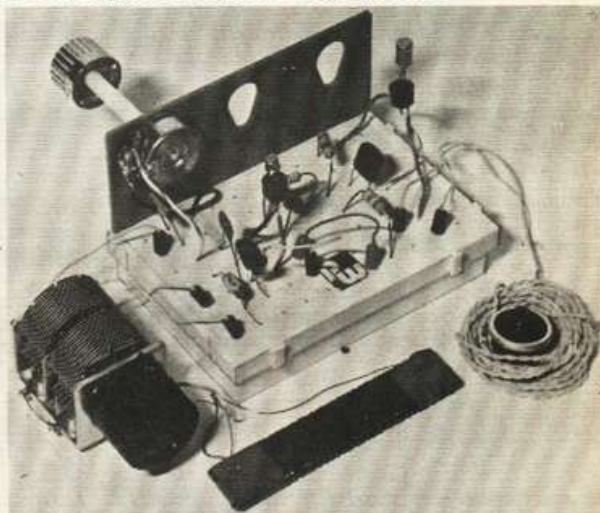
If the unit does not work, check all wiring very carefully. Check the +8 Volts supply to the I.C., modulator and the clock generator. If an oscilloscope is available, check that the oscillator is working and producing sufficient drive for the buffer, Tr2, and is approximately 2MHz.

If the I.C. has +8 Volts and a good clock signal, check the sync output. This should consist of negative going pulses 4μS wide, at 64 μS intervals with an approx. 300 μS frame pulse every 20 mS. If this is present, check the field and score output on pin 24, this should be a positive-going pattern repeating every 20 mS. If this is present, check that both these signals appear at the wiper of VR3. If all is well up to this point and the unit is still not working, check the modulator construction very carefully. As it is difficult to check if it is working it is possibly easiest to substitute a new transistor for Tr5.

Watford Electronics have offered to keep their special reduced price for the AY-3-8500 open to readers of Practical Wireless *until the end of June 1977.*

S-DeCnology—*continued from page 122.*

of the wire, especially the tapping loop and tin these connections before soldering on some wired S-DeC plugs. If desired, the wire from the coil itself may be plugged into the S-DeC but you will still need to use some form of single core wire from the tapping point to the S-DeC because the twisted wire, being double thickness, will not easily plug into the S-DeC and may even damage it if forced. A second ferrite aerial/coil was wound on a 125mm. length of ferrite rod, 9mm in diameter and also gave good results.

The tuning capacitor used in the prototype was a twin gang 500pF+500pF. There is no reason why a single capacitor of either 500pF or 350pF should not be used, but this will make some difference to the actual tuning scale covered by the receiver. The twin gang does give a useful opportunity for experiment. For example, with both sections connected in parallel—as shown in the circuit diagram of Fig. 1, one has a 1,000pF (or 1nF) variable tuning capacitor. By "unlinking" the two sections of VC1/VC2 to leave only one of them in circuit, one has a 500pF tuning capacitor. Again, connecting the two sections in series gives a 250pF tuning capacitor.

Rear view photograph showing the actual receiver, comprising S-DeC front mounted potentiometer, and external components.

Modification ideas

Experimentally minded constructors may care to try altering the coil. For example, using only 24 turns tapped at 2 turns gave all sorts of 'funny' foreign stations. It may even be possible to obtain good results high up in the short wave bands.

This little receiver runs from just 3V. This is the optimum voltage. If you use a higher voltage the performance will be degraded. The current drawn by the prototype (using 3V) was 1·5mA which suggests that batteries should last for a very long time indeed. It may also be possible to run the receiver from two, small rechargeable batteries which could be kept 'topped up' from solar cells using sunlight. Perhaps the set may be happy to work directly from solar cells?

Various component changes and modifications were tried but it's left to the constructor to experiment for himself, with different component values, to obtain the best possible results.

WATFORD ELECTRONICS

(Continued from opposite side)

DIODES	
AA119	15p
AAZ15	15p
AEY11	60p
BA100	10p
BA102	10p
BY100	24p
BY126	14p
BY127	14p
OA9	9p
OA47	8p
OA70	8p
OA79	12p
OA81	15p
OA85	12p
OA90	6p
OA91	6p
OA95	8p
OA200	9p
OA202	8p
IN914	4p
IN916	5p
IN4001/2*	5p
IN4003*	6p
IN4004/5*	6p
IN4006/7*	7p
IN4148	4p
IS44	20p
3A/100V*	18p
3A/400V*	20p
3A/600V*	27p
3A/1000V*	30p
6A/400V	50n

*BRIDGE RECTIFIERS (plastic case)	
1A50V	20p
1A100V	22p
1A200V	25p
1A400V	29c
1A600V	34p
2A50V	35p
2A100V	44p
2A200V	46p
2A400V	53p
4A100V	72p
4A/200V	75p
4A400V	79p
4A800V	120p
6A100V	73p
6A/200V	78p
6A400V	85p
6A/600V	99p
BY164	56p

ZENERS	
Rng:3·3V–33V	
400mW	9p
1·3W	17p

VARICAPS	
MVAM2	135p
BB104	40p
BB105B	40p
BB106	45p

Noise Diode	
Z5J	105p

SCR's* Thyristors	
1A50V	38p
1A100V	42p
1A200V	47p
1A400V	52p
1A600V	70p
3A50V	38p
3A100V	43p
3A200V	60p
3A400V	110p
3A600V	120p
5A400V	120p
7A400V	125p
8A400V	150p
BT106	150p
C106D	55p
TIC44	25p
TIC45	45p
2N4444	191p

TRIACS*	
3A400V	113p
6A400V	140p
8A400V	160p
10A500V	195p
15A400V	200p
15A500V	285p
30A400V	398p
40430	99p
40669	104p

DIAC*	
ST2	25p

ALUM. BOXES with lid*	
2¾x5¼x1½"	64p
4x4x1½"	64p
4x2¼x1½"	63p
4x5¼x1½"	70p
4x2½x2"	64p
5x4x2"	86p
6x4x2"	91p
7x5x2½"	114p
8x6x3"	142p
10x7x3"	160p
10x4½x3"	142p
12x5x3"	160p
12x8x3"	205p

CASES:	
NJHC1	85p
NJSF2	275p

SPEAKERS	
8Ω 0·3W 2"; 2¼"	65p
2·5; 3"	58p
64Ω 2·5"	65
8Ω 5W 7" x 4"	190p
16Ω 5W 7 x 4"	205p

COPPER CLAD BOARDS*

Fibre glass	single sided	dble/ sided	S.R.B.P. 7½"x8½"
6"x6"	64p	78p	
6"x12"	115p	160p	40p

FERRIC CHLORIDE* 1lb bag Anhydrous 65p + 30p p. & p.

DALO ETCH RESIST PEN* + spare tip 75p

VEROBOARD* Pitch

	0·1	0·15 (copper clad)	0·15 (plain)
2½ x 3¾"	38p	29p	19p
2½ x 5"	43p	39p	24p
3¾ x 3¾"	43p	40p	—
3¾ x 5"	48p	53p	34p
2½ x 17"	134p	107p	73p
3¾ x 17"	173p	143p	85p
4¾ x 17"	222p	—	145p
Pkt of 36 pins			28p
Spot face cutter			69p
Pin insertion tool			89p

OPTO ELECTRONICS*

LEDS + Clip	
TIL209 Red	13p
TIL211 Grn	23p
TIL220 Red	20p
·2" Red	17p
Yellow, Green, Amber	21p
OCP70	40p
ORP12	68p

7 Segment Displays	
TIL312 ·3" C.An	125p
TIL313 3" C.Cth	125p
TIL321 5" C.An	140p
TIL322 5" C.Cth	140p
DL704 ·3" C.Cth	99p
DL707 ·3" C.Anod	99p
DL747 6" An	180p
MAN3610 C. An	256p
MAN3640 C. Cath	260p
MINITRON 3015F	240p
2N5777	54p

OPTO ISOLATORS	
TIL111/2	105p
TIL114	110p
TIL117	164p

DRIVERS	
75491	80p
75492	90p

VOLTAGE REGULATORS*

723 DIL	45p
723 TO5	53p
TBA625B	95p
T03 Can Type	
1A 5V	170p
1A 12V	180p
1A 15V	190p
1A 18V	210p
LM309K	150p
LM323K	625p
MVR5	180p
MVR12	180p
1A –5V	220p
1A –12V	220p

Plastic Case	
78L82AWC 1A 8V	51p
MC7805 1A5V	135p
MC7812 1A 12V	135p
MC7815 1A 15V	135p
FT8N24 1A 24V	140p
Variable Type	
LM325N ±15V	240p
LM326N ±12V	240p
LM327N ±5 –12	280p
LM317K 20W 1·5A +1·2V to 37V	350p
LM317H 5W 1·5A +1·2V to 37V	320p

It's here! . . . The "OLYMPIC" TELEVISION GAME

This is an easy to build no compromise kit using the very latest Integrated Circuit only just available from the United States. Simply plug into the U.H.F. Aerial socket of any standard Television Receiver, sit back in your favourite armchair and spend countless hours with the family playing any of the six games available.
The central Control Unit provides Game selection with switching for Bat size, Angle and Ball speed adjustment. The Bat position, Score reset and Serve controls being remotely connected allowing players to be many feet apart. The Unit is mains powered (no expensive batteries to buy) and incorporates the unique "Ventriloquist" audio system which produces realistic Game sounds from your Television speaker.
Also included are instructions to build the "Sure Fire" rifle. A simple design which is made foolproof by the "On Target" detector incorporated in the electronics. Complete kit **£27·85** incl. VAT. (P & P insured add 85p). (Components may be ordered individually). Send SAE for details. (Demonstration on at our shop).

SWITCHES* TOGGLE: 2A, 250V	
SPST	26p
DPDT	35p
4 polechangeover	58p

SUB-MIN TOGGLE	
SP changeover	59p
SPST on/off	54p
DPDT 6 tag	78p
DPDT Centre off	92p
DPDT Biased	115p

JACK PLUGS	Screened chrome	Plastic body
2·5mm	12p	8p
3·5mm	15p	10p
MONO	23p	15p
STEREO	31p	18p

SOCKETS	Open metal	Moulded with break contacts
2·5mm	8p	
3·5mm	8p	
MONO	13p	20p
STEREO	15p	24p

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